

Stormwater Green Infrastructure: Evaluation and Performance

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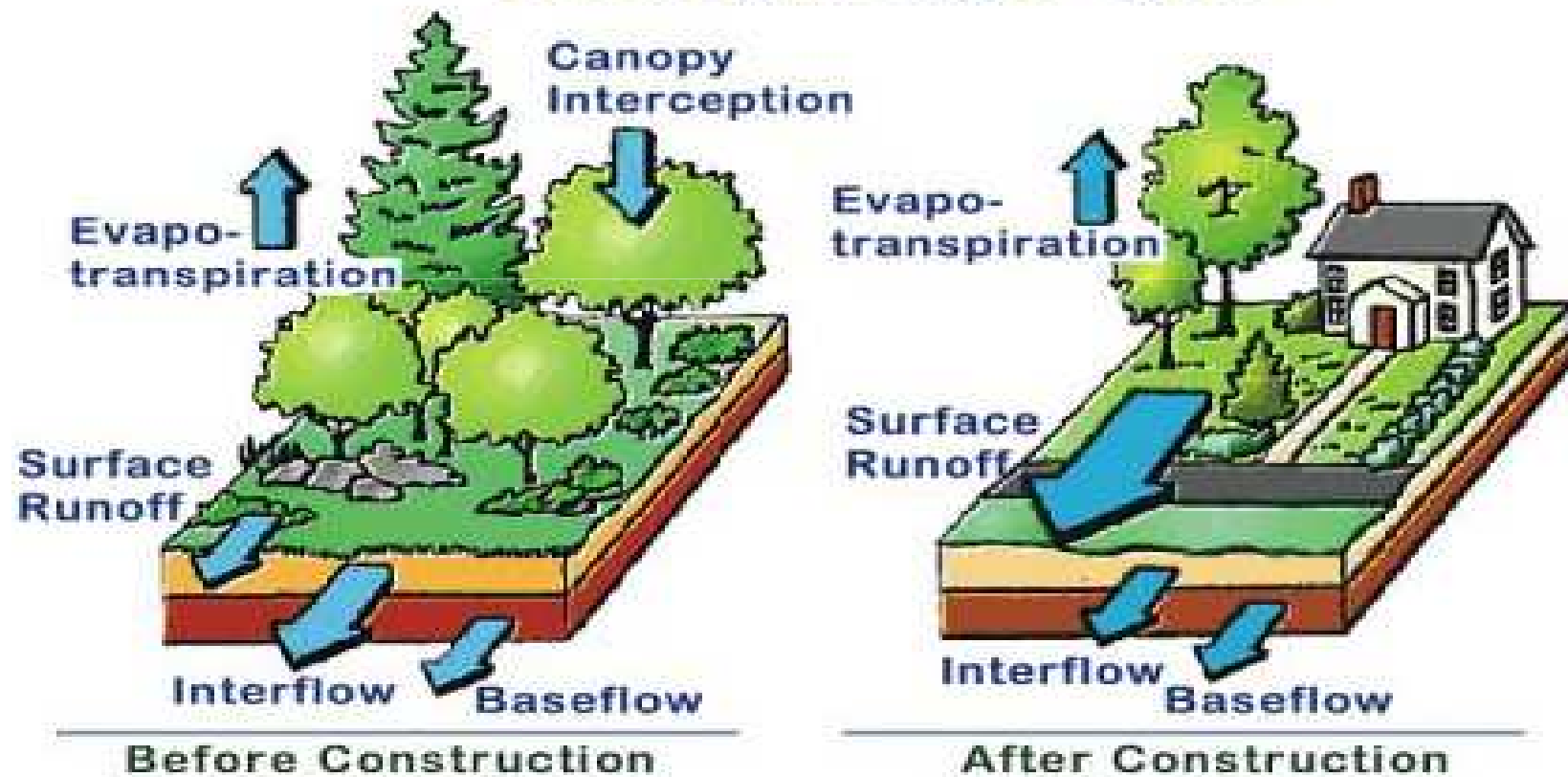
Texas A&M AgriLife Extension

Dallas Research and Extension Center



Urban vs. Natural

Local Hydrologic Cycle



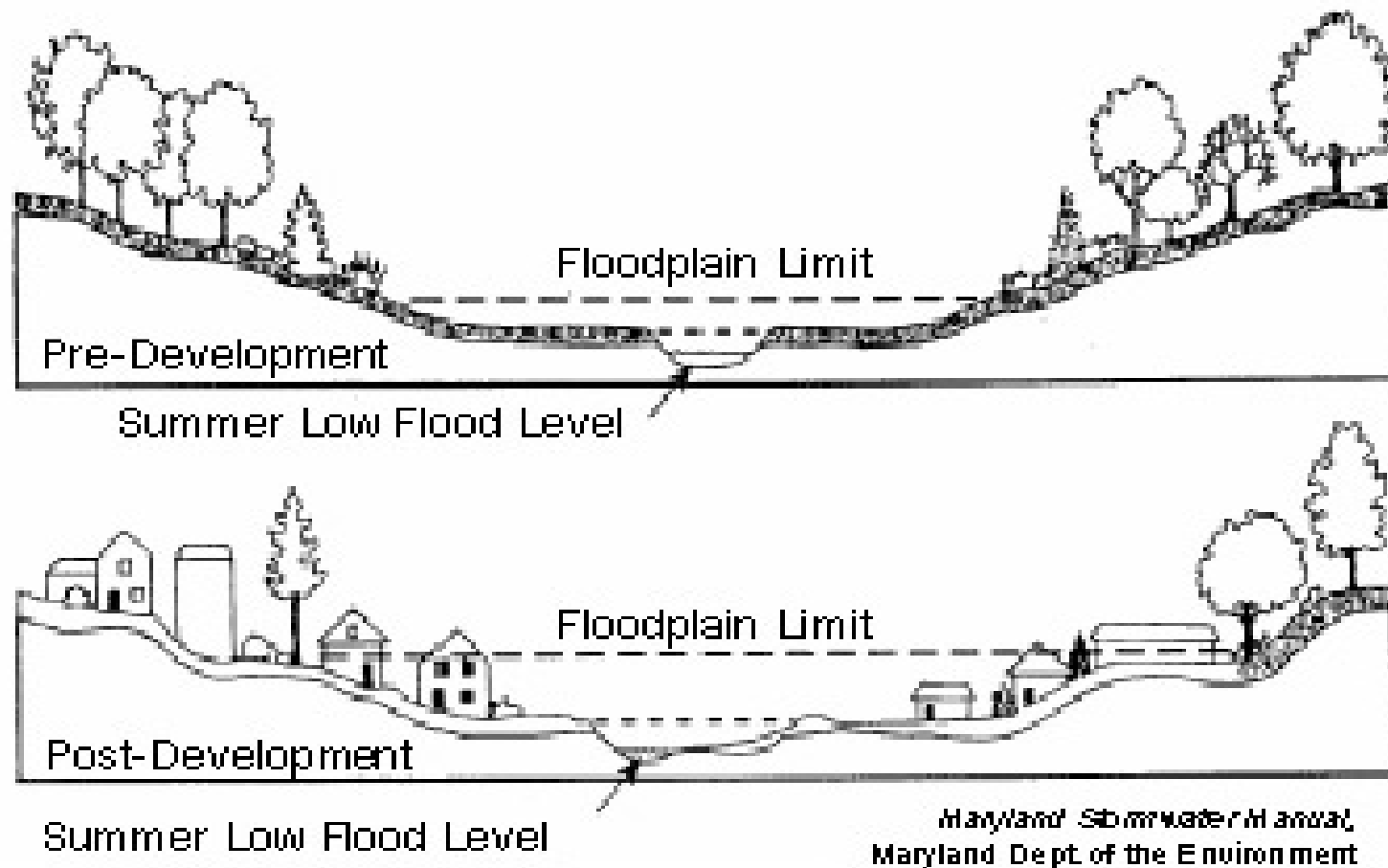
Why is Stormwater a Concern?



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Eutrophication

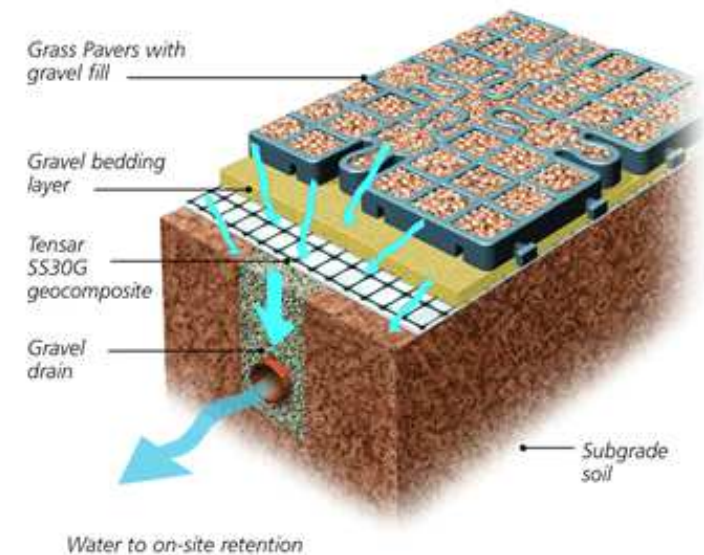
- Impacts due to urbanization:
 - **Impact to aquatic habitat:** Degradation of habitat structure, loss of pool-riffle structure, reduction in base flow, increased stream temperature, and decline in abundance and biodiversity.



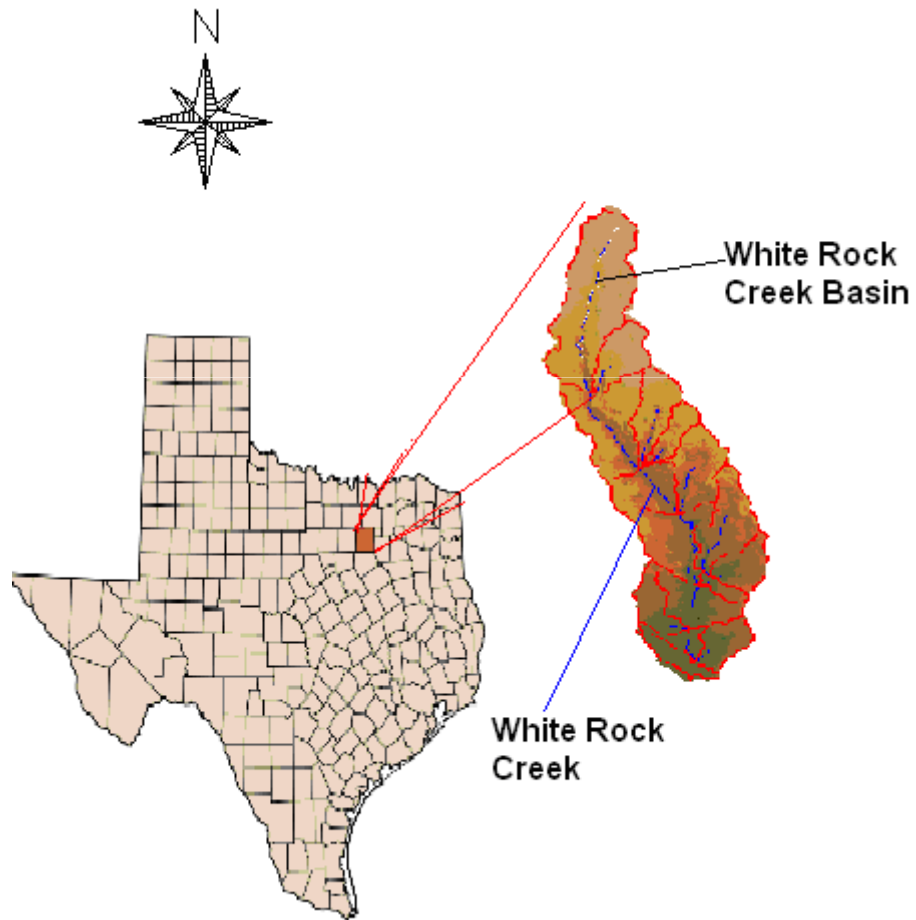
Fish kill at Lake Granbury.

Urban BMPs

- ❑ Rain garden-bioretention areas
- ❑ Porous pavements
- ❑ Green roofs
- ❑ Rainwater harvesting



Project Location



□ Upper Trinity-White Rock Creek Watershed

□ Clayey soil with underlying calcareous layer (Blackland Prairie Ecosystem)

□ Representative of typical urban watershed

GRAPHIC SCALE : 1" = 50'

COIT ROAD

PHASE 3

Rain Garden

Detention Pond

C-109

PHASE 2

PHASE 2 - 1A

C-101 & C-103

C-102

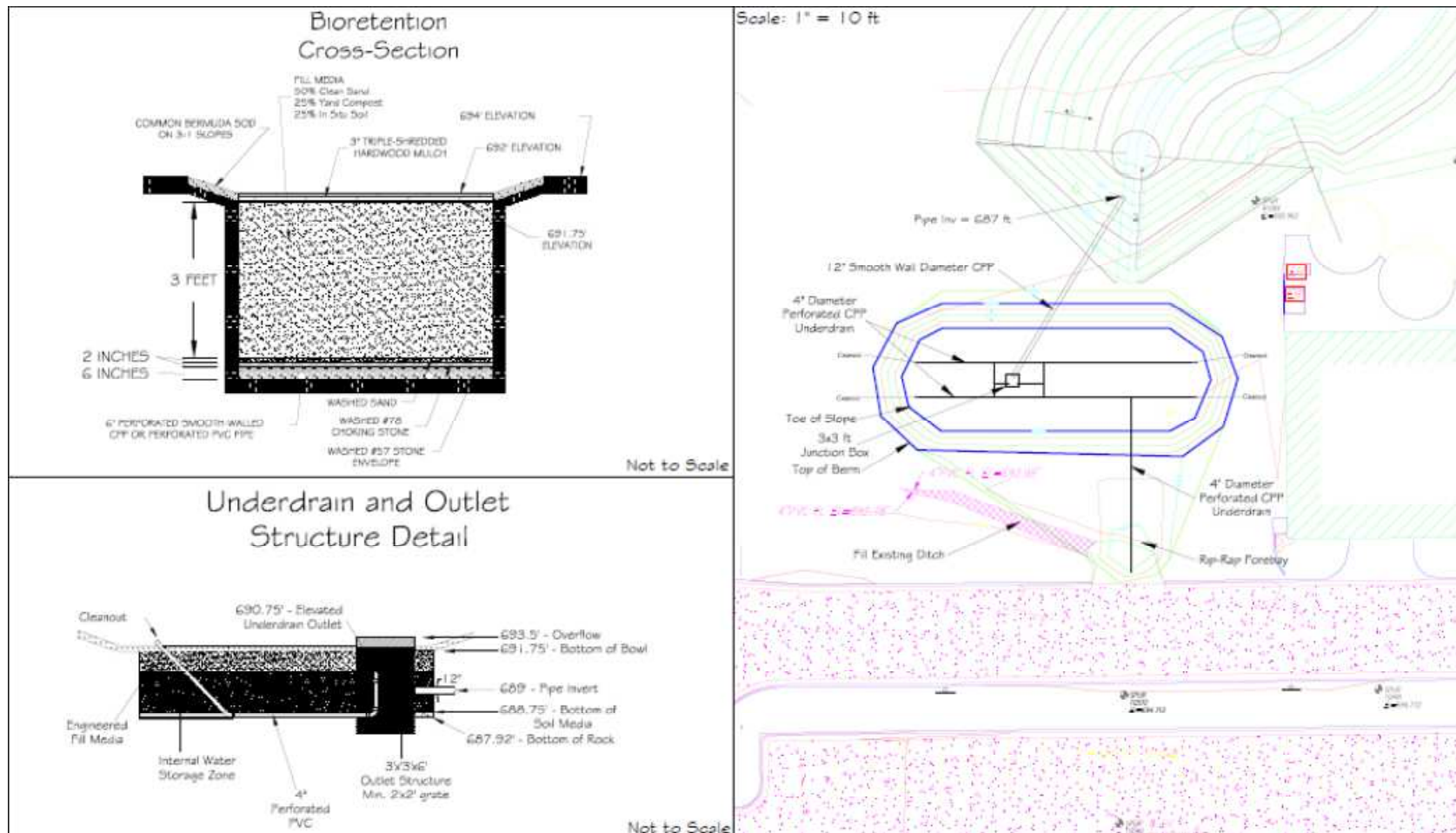
Permeable pavement

Green roof

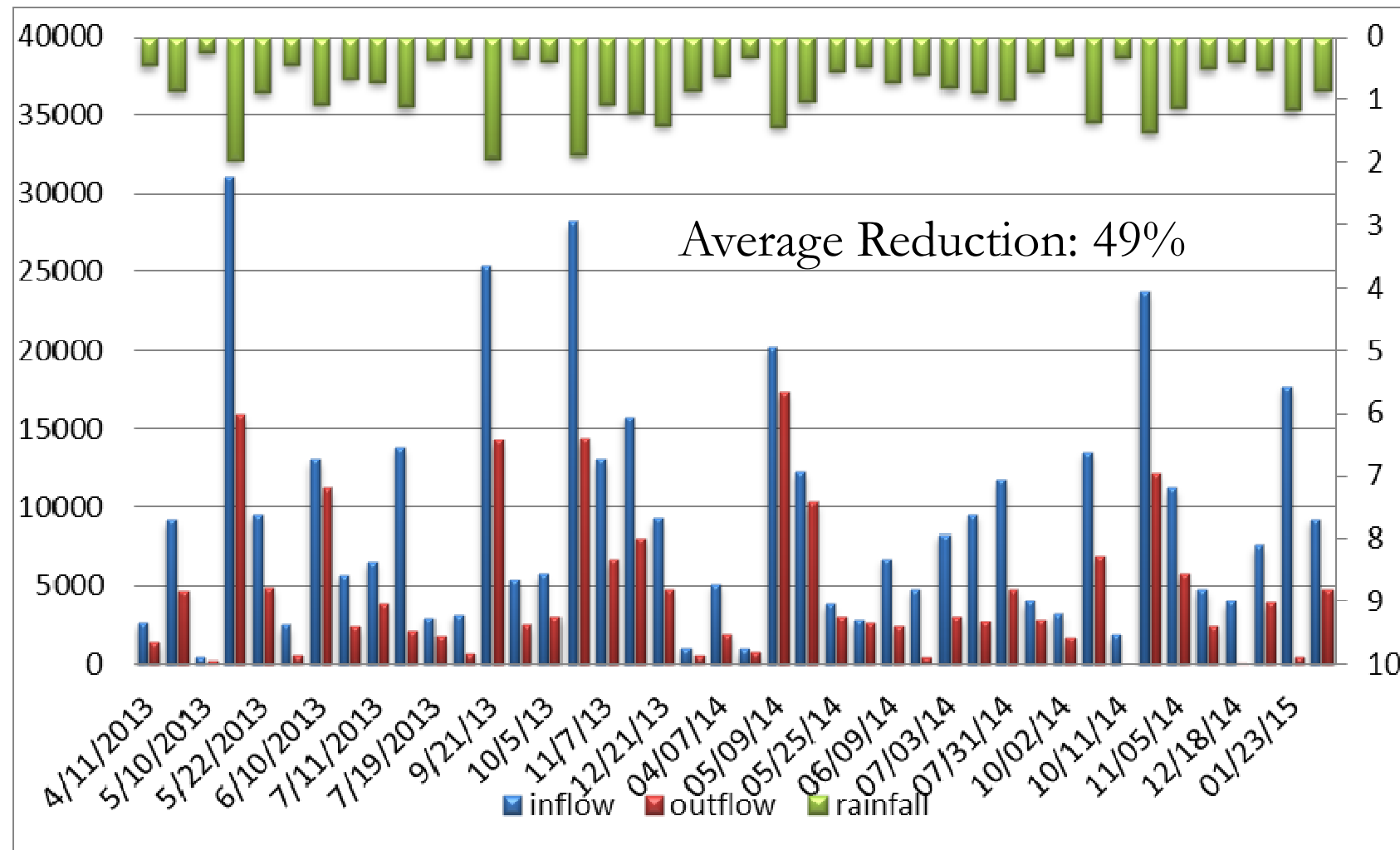
RWH

KEY MAP/PROJECT LAYOUT

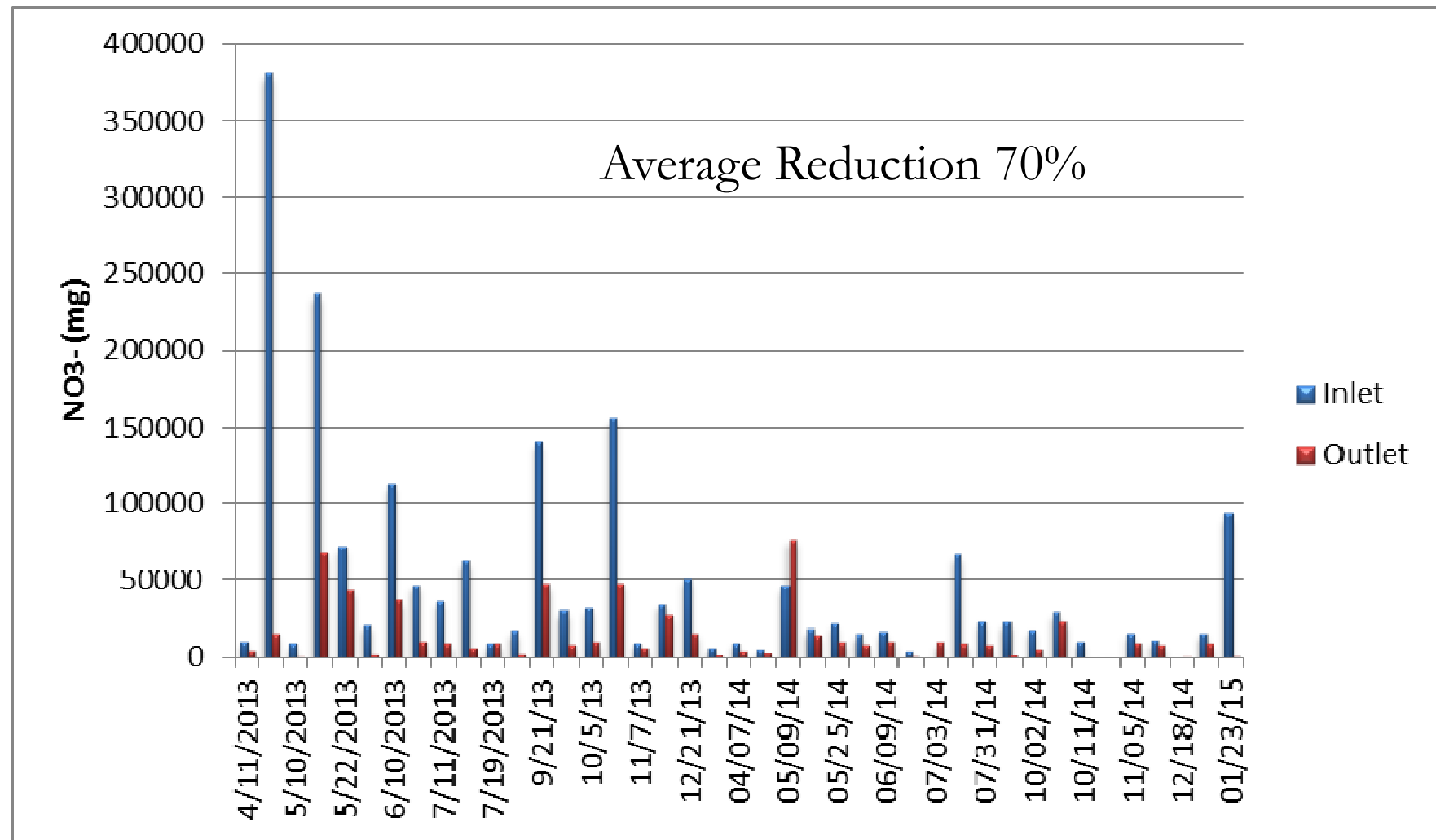
Bioretention Area



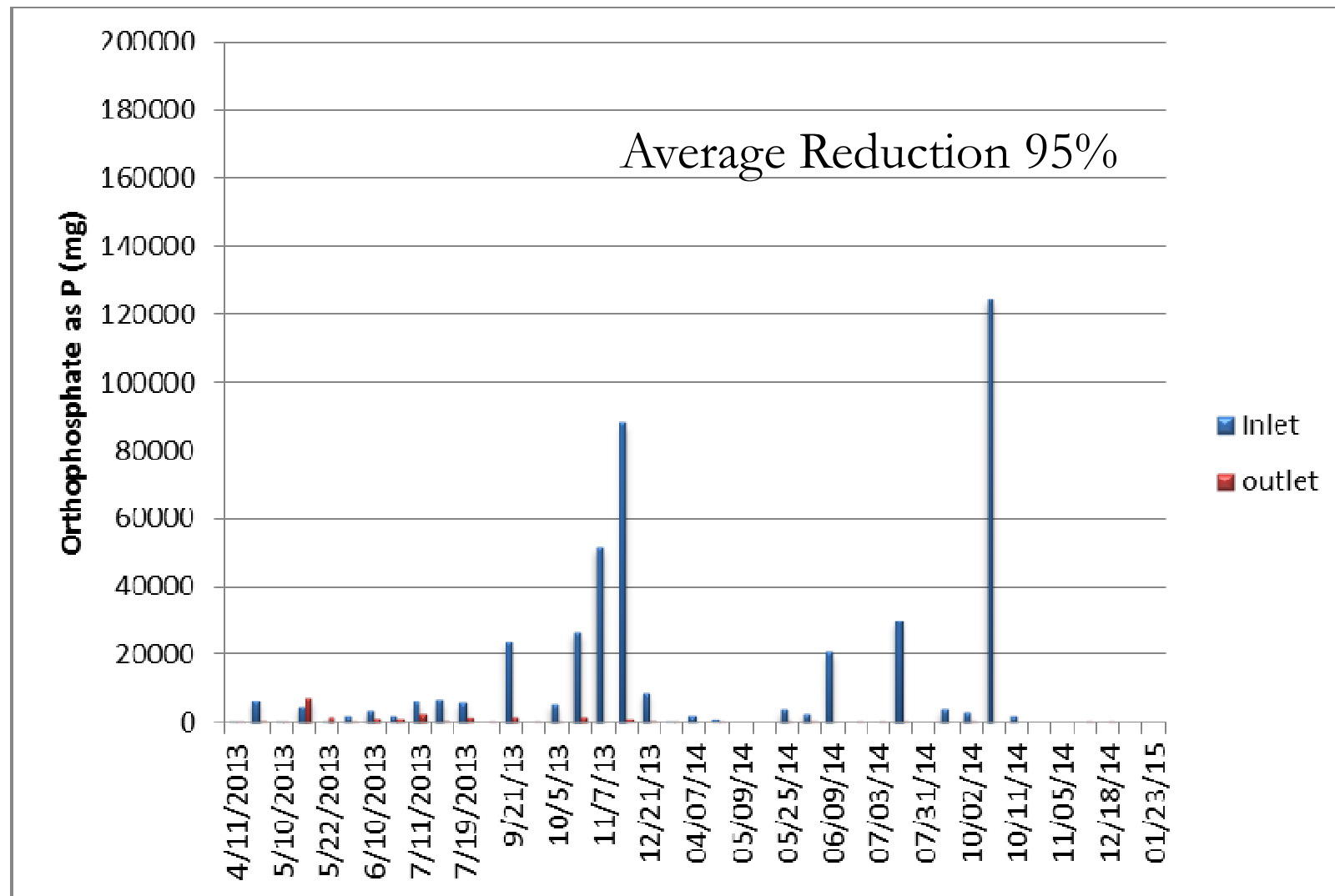
Volume Reduction



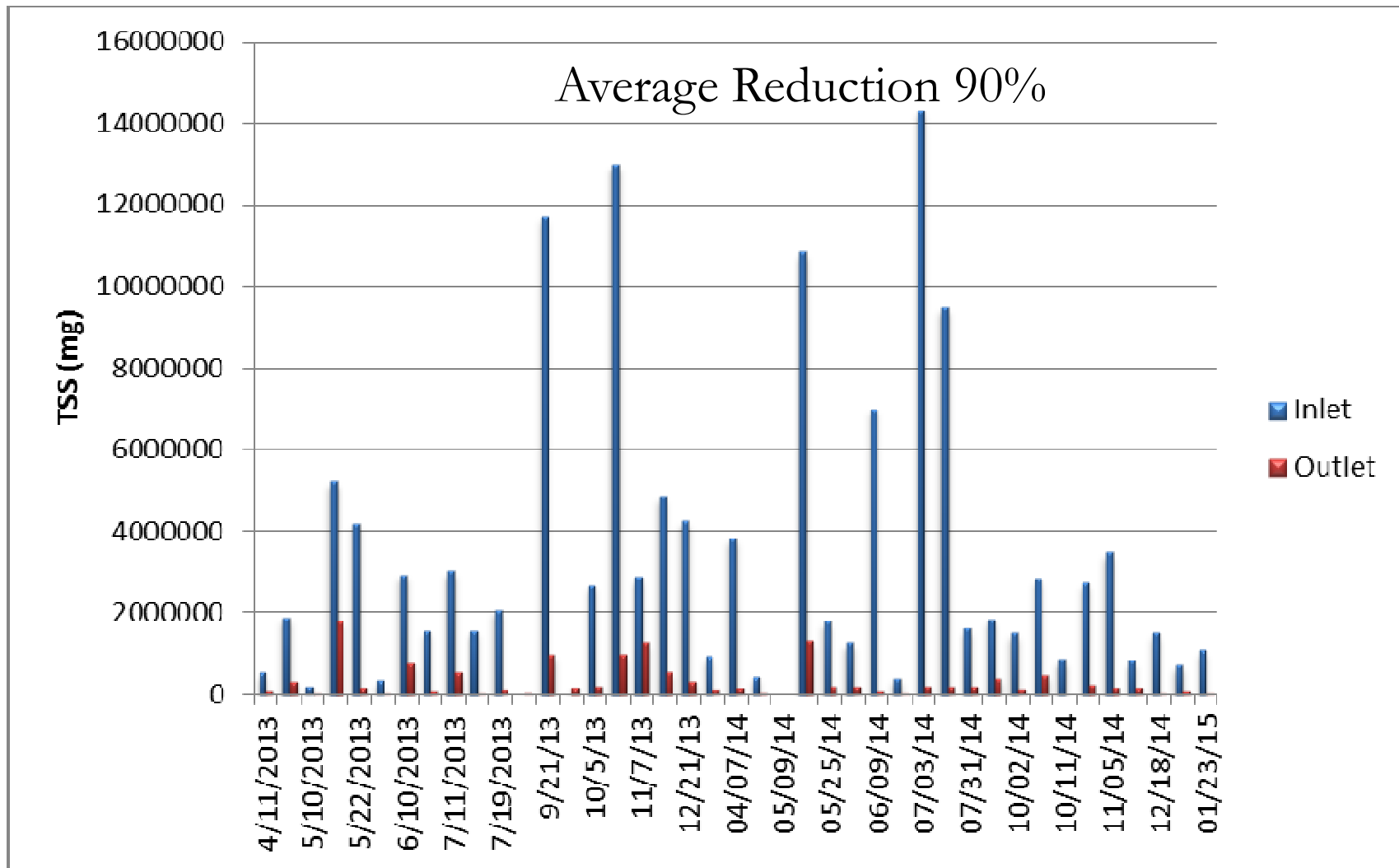
Load Reduction: Nitrate



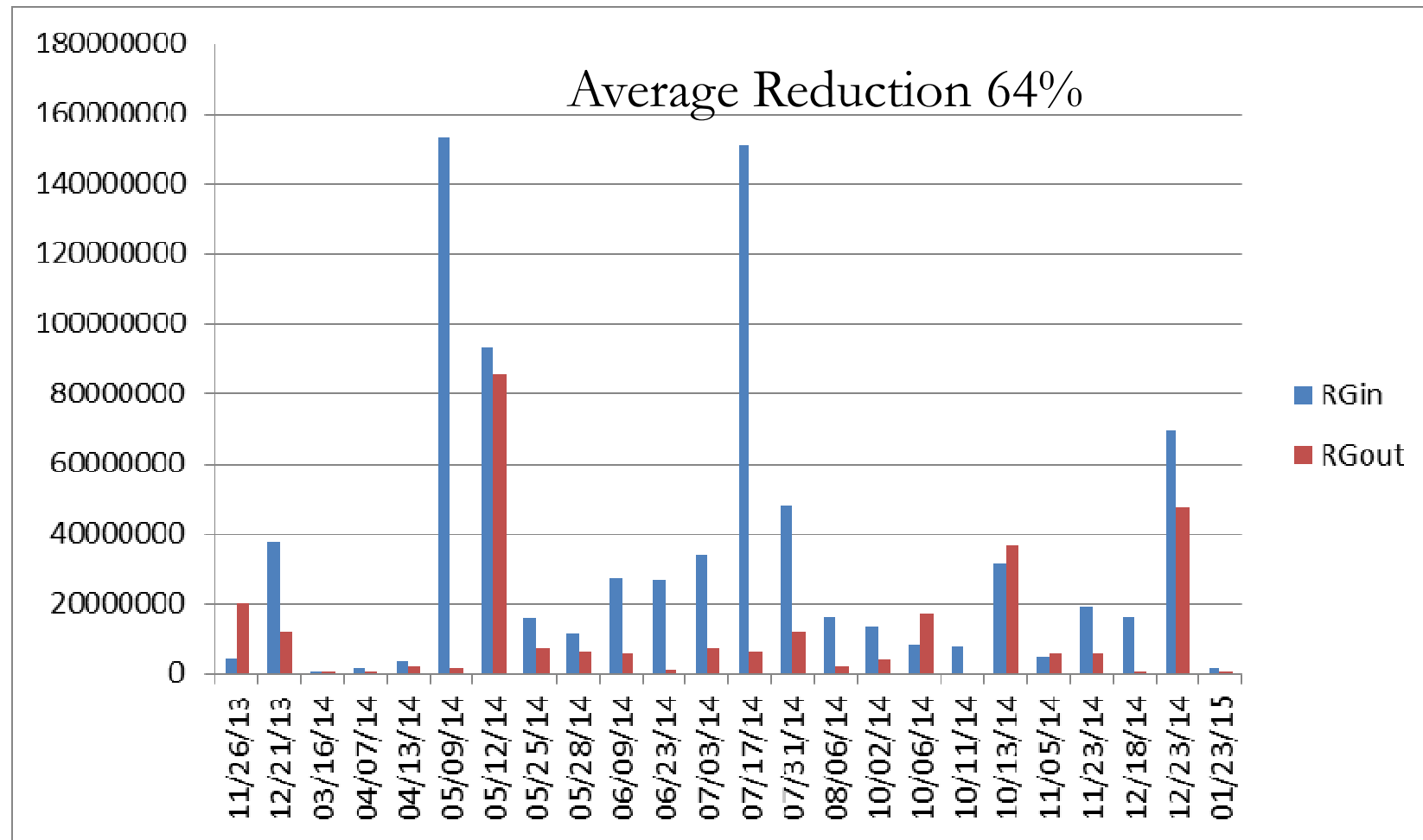
Load Reduction: Orthophosphate



Load Reduction: Sediments



Load Reduction: E. coli

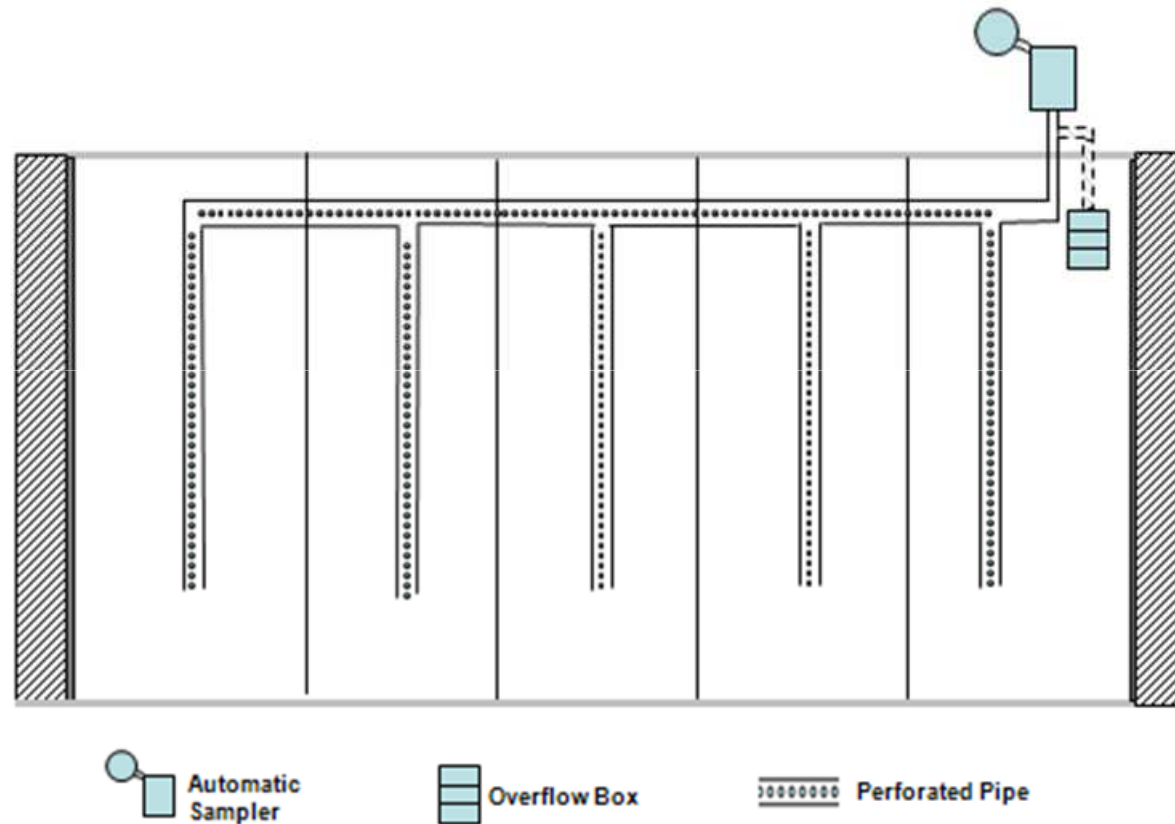




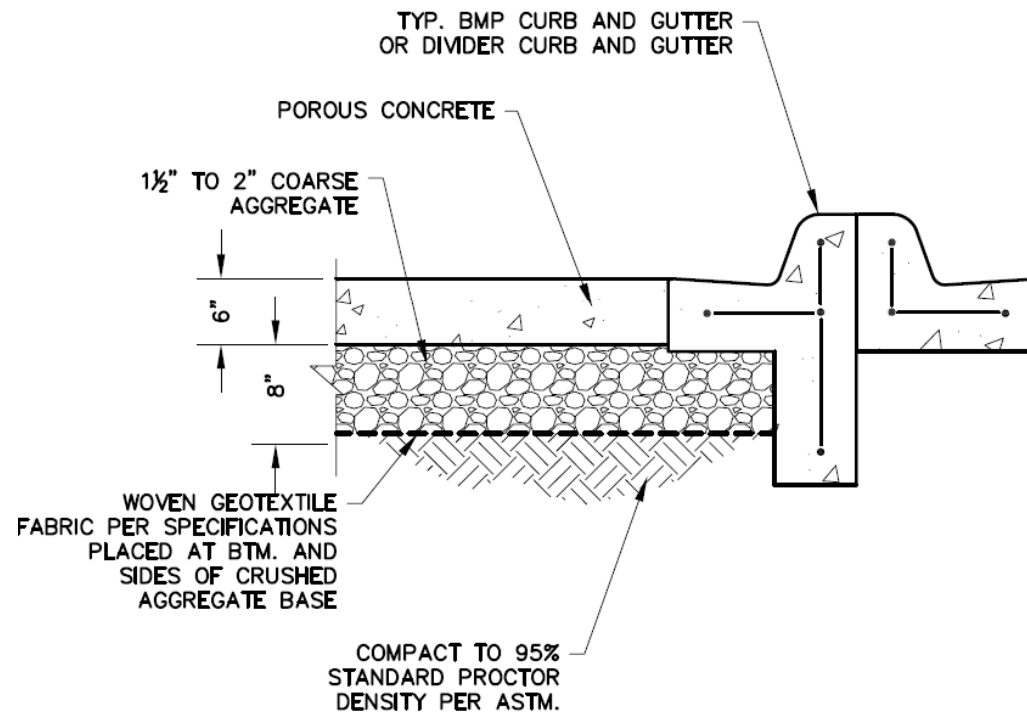


Design and Monitoring

- Stalls: 18'x10'
- ISCO samplers with bubbler flow meters
- Runoff quantity and quality is measured



Pervious Concrete Cross Section

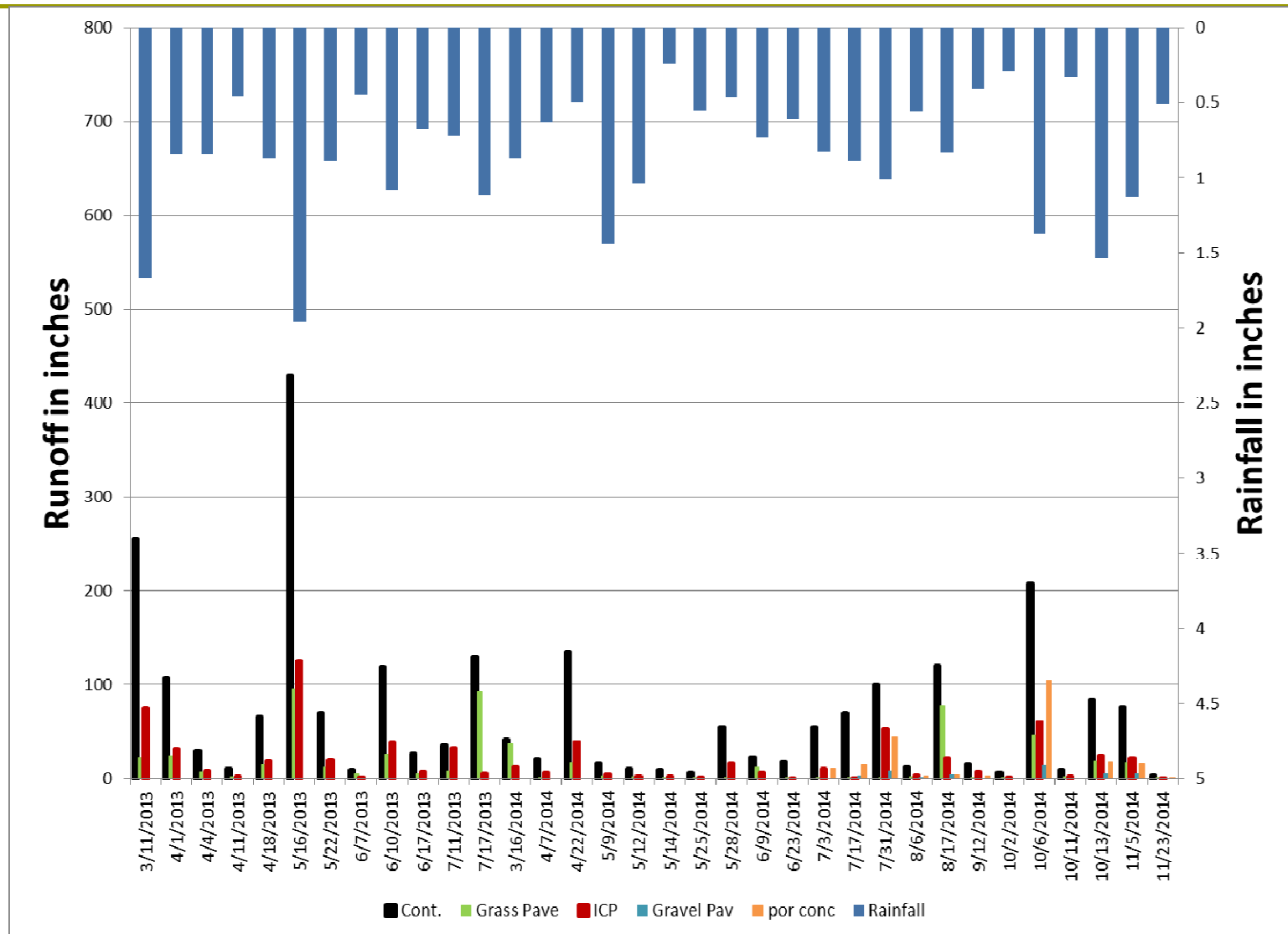


POROUS CONCRETE

NOT TO SCALE

2

Results: Volume



Volume Reduction Rates

	PICP	Pervious Concrete	Grass Pavers	Gravel Pavers
Reduction Rate	71%	74%	78%	93%

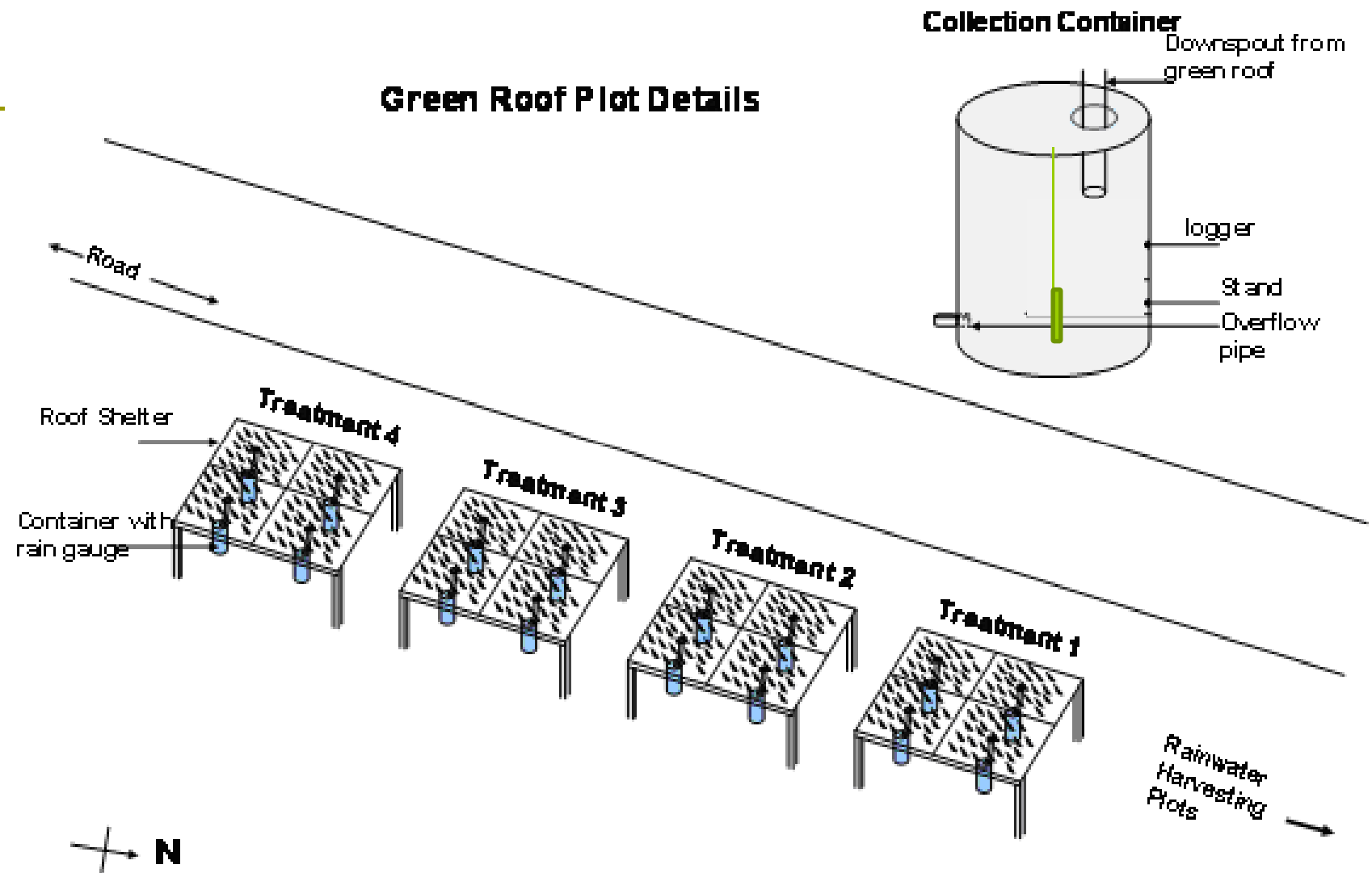
Results: Water Quality

	Control (mg)	Grass Pave (mg)	Grass Pave % reduction	ICP (mg)	% reduction
NO3	221.98	857.55	-286%	654.27	-195%
NH4	272.07	173.43	36%	60.64	78%
TKN	2327.54	1760.51	24%	1023.3	56%
Orthophosphate	2.46	12.08	-391%	20.84	-747%
Total Phosphorus	53.66	85.37	-59%	107.87	-101%
TSS	59833.46	9648.71	84%	32306	48%

TSS Reduction in Per Conc: 57%
in Gravel pavers: 48%



Green Roof Plot Details

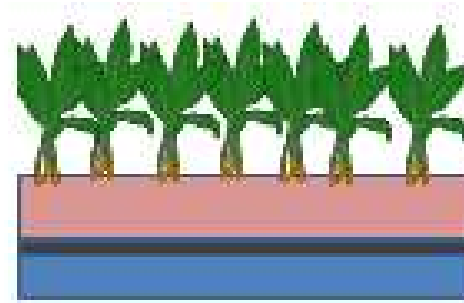




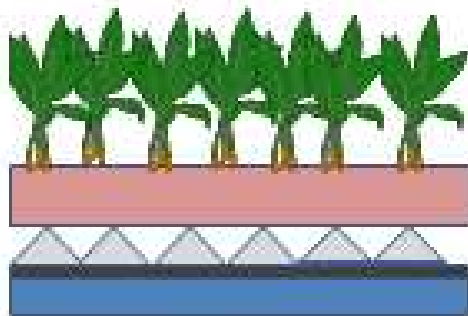
Growth Medium



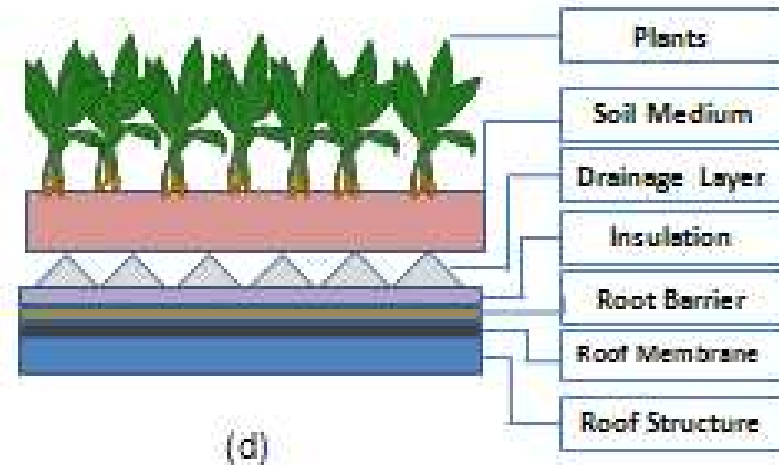
(a)



(b)



(c)



(d)

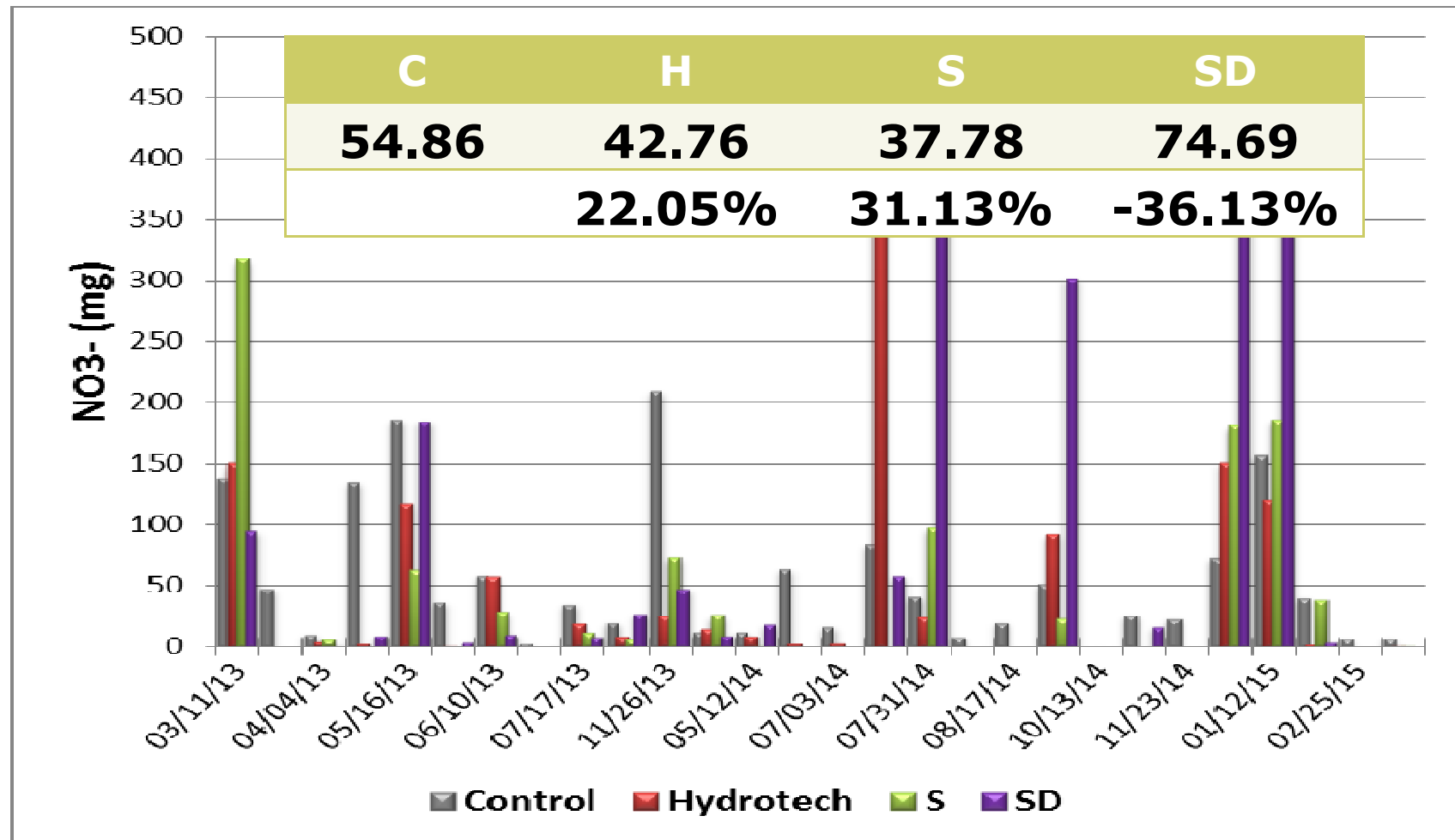
Volume Reduction

Event	Rainfall	C	H	H reduction	S	S reduction	SD	SD Reduction
Date	inches	gals	gals	%	gals	%	gals	%
12/28/12	1.52	13.04	8.67	33.51%	8.40	35.58%	8.62	33.90%
01/10/13	2.61	39.13	25.67	34.40%	23.13	40.89%	28.15	28.06%
02/11/13	0.9	8.40	5.13	38.93%	5.19	38.24%	2.18	74.05%
03/11/13	1.67	19.71	7.02	64.38%	12.51	36.53%	6.31	67.99%
04/01/13	0.84	2.71	0.00	100.00%	0.00	100.00%	0.00	100.00%
04/04/13	0.84	3.51	1.30	62.96%	1.29	63.25%	1.29	63.11%
04/18/13	0.87	6.96	0.70	89.94%	0.00	100.00%	1.18	83.05%
05/16/13	1.96	24.61	5.62	77.16%	2.63	89.31%	7.32	70.26%
05/22/13	0.89	4.25	0.10	97.67%	0.00	0.00%	0.36	91.53%
06/10/13	1.08	7.73	2.42	68.69%	1.18	84.73%	0.67	91.33%
06/17/13	0.67	0.80	0.00	100.00%	0.00	100.00%	0.00	100.00%
07/11/13	0.72	1.72	0.00	100.00%	0.00	100.00%	0.30	82.53%
07/17/13	1.12	9.27	4.07	56.09%	1.60	82.74%	2.86	69.19%
09/21/13	1.93	7.44	5.37	27.82%	1.12	84.95%	2.66	64.25%
10/16/13	1.88	7.26	3.25	55.23%	5.78	20.39%	3.6	50.41%
10/27/13	1.24	5.25	4.43	15.62%	4.25	19.05%	2.83	46.10%
11/05/13	1.08	5.55	2.54	54.23%	0.04	99.28%	2.24	59.64%
11/26/13	1.22	3.89	0.53	86.38%	1	74.29%	0	100.00%
12/21/13	1.42	7.02	4.19	40.31%	4.4	37.32%	6.96	0.85%

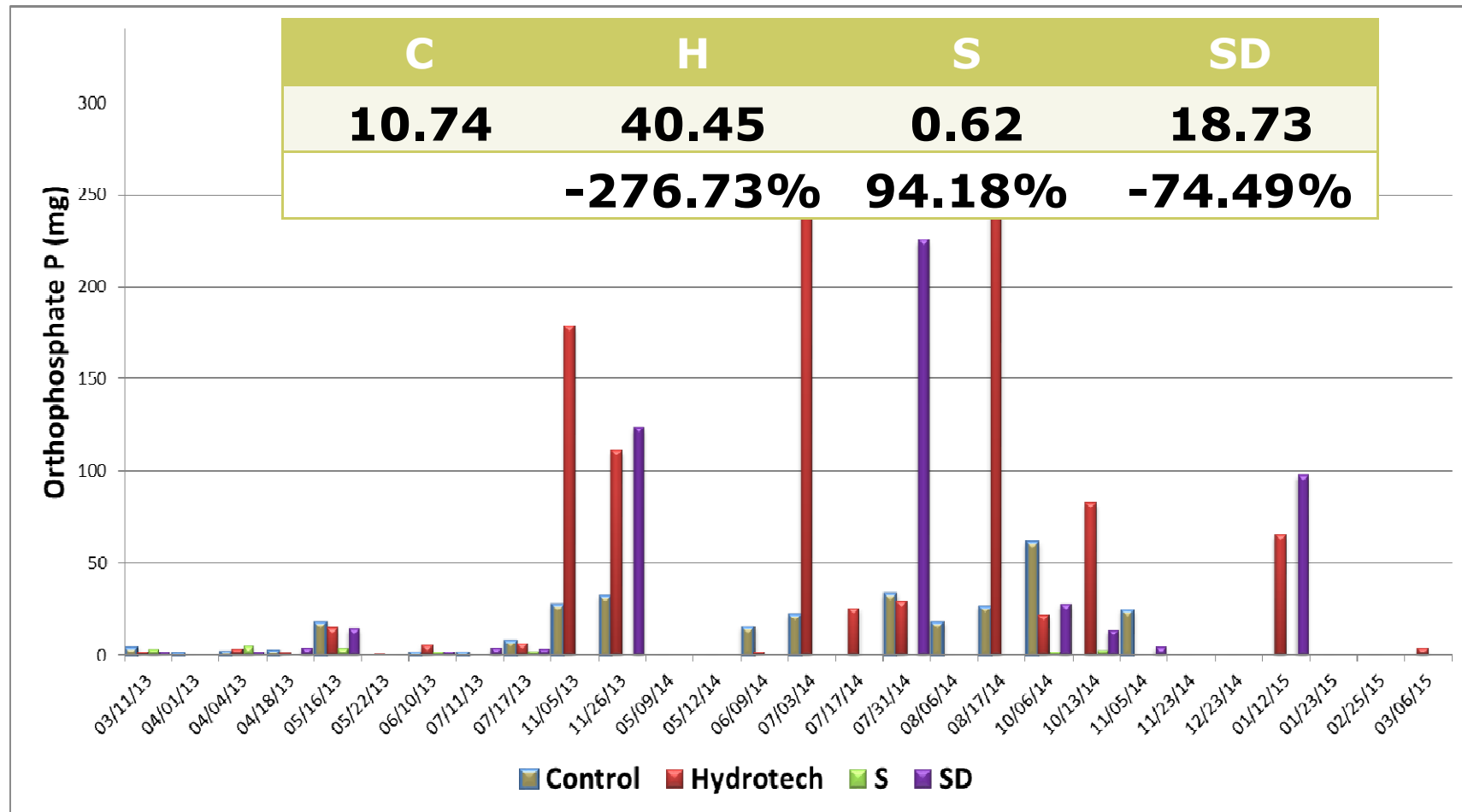
Volume Reduction

Event	Rainfal l	C	H	H reductio n	S	S reductio n	SD	SD Reductio n
Date	inches	gals	gals	%	gals	%	gals	%
05/09/14	Total Volume Reduction from C			65.39%		76.05%		75.33 %
05/12/14								
06/09/14								
07/03/14								
07/17/14	0.82	5	3.4	0.32	0.17	0.97	0.17	0.97
07/31/14	0.89	6.7	1.47	0.78	0.1	0.99	2	0.70
08/06/14	1.01	7.7	6.1	0.21	0.24	0.97	1.18	0.85
08/17/14	0.56	2.7	0	1.00	0	1.00	0.29	0.89
10/06/14	0.83	4.7	1.18	0.75	0	1.00	0.29	0.94
10/13/14	1.37	15.8	5.54	0.65	2.47	0.84	4.1	0.74
10/13/14	1.54	22	11.9	0.46	8.7	0.60	9.3	0.58
11/05/14	1.54	22	11.9	0.46	8.7	0.60	9.3	0.58
11/23/14	1.13	9.02	0.17	0.98	0.35	0.96	0.29	0.97
12/23/14	0.51	2.5	0	1.00	0	1.00	0	1.00
01/12/15	0.53	3.89	0.59	0.85	0.35	0.91	0	1.00
01/23/15	0.63	4.5	0.66	0.85	2.4	0.47	0.94	0.79
02/02/15	1.17	7.58	3.56	0.53	3.63	0.52	3.28	0.57
02/25/15	0.72	35.7	25	0.30	1.12	0.97	0	1.00
03/06/15	2.22	15.58	8.63	0.45	1.36	0.91	5.66	0.64
	1.1	2.36	0	1.00	1.35	0.43	0.17	0.93

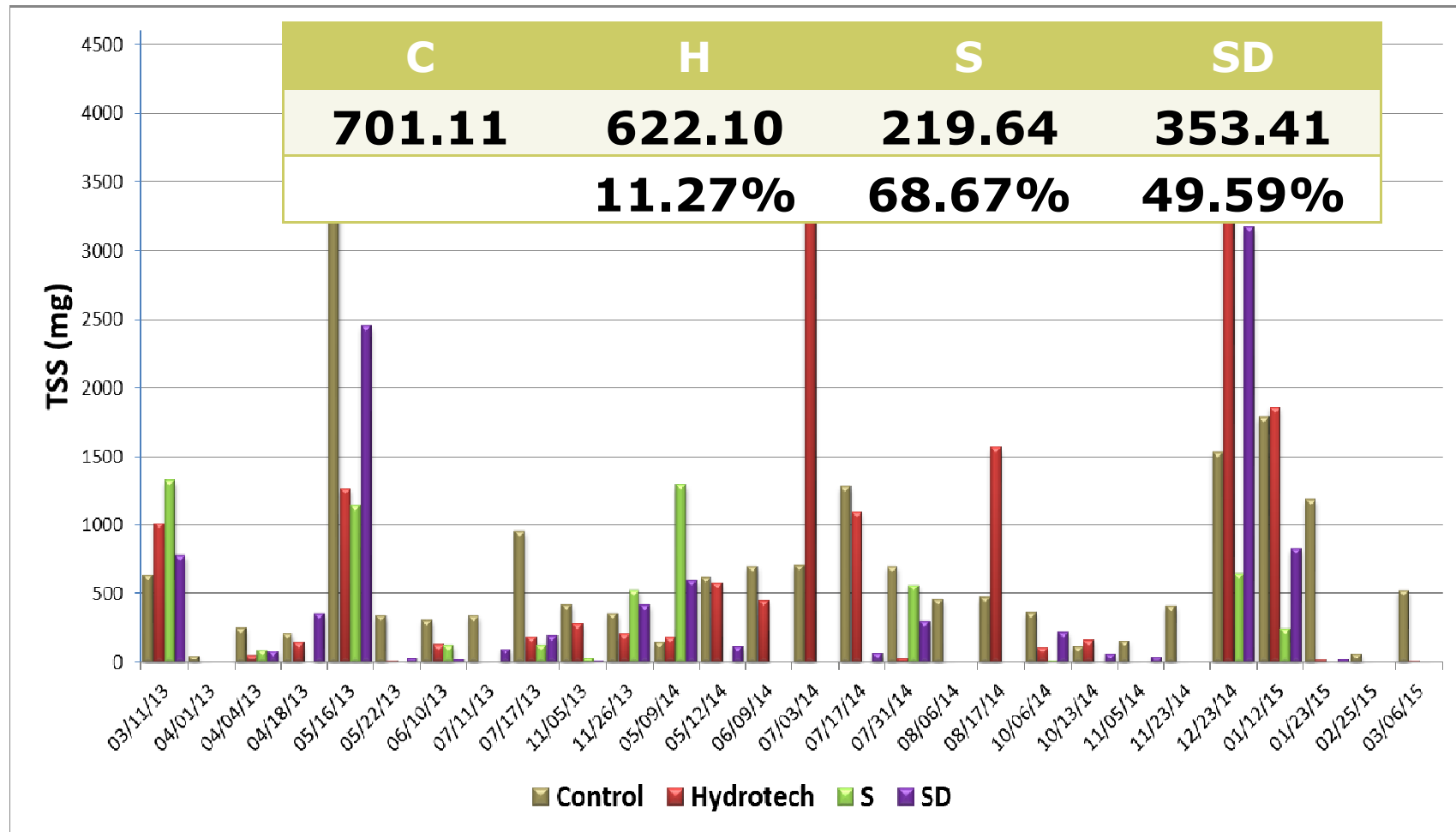
Nitrate Loads



Orthophosphate Loads



TSS Loads



Rainwater Harvesting

❑ Demonstration Component

- Four cisterns (300, 500, 1500, and 2500 gallon) that serve AgriLife Buildings
- Storage and outflow measured
- Serves a drip irrigation system

❑ Experimental Component

- 4 roof shelters, represent residential roofs, 55 gallon tanks(3/plot)
- Turf lawn associated with each, drip irrigation
- 4 Treatments- Soil moisture, Evapotranspiration, Home owner (rain water), Control: Home owner (city water)
- Inflow, outflow, water quality

Experimental plot layout

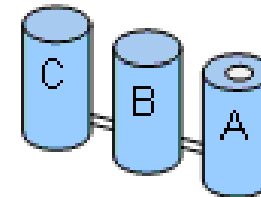
Rainwater Harvesting Treatments

Plot 1 – Soil Moisture

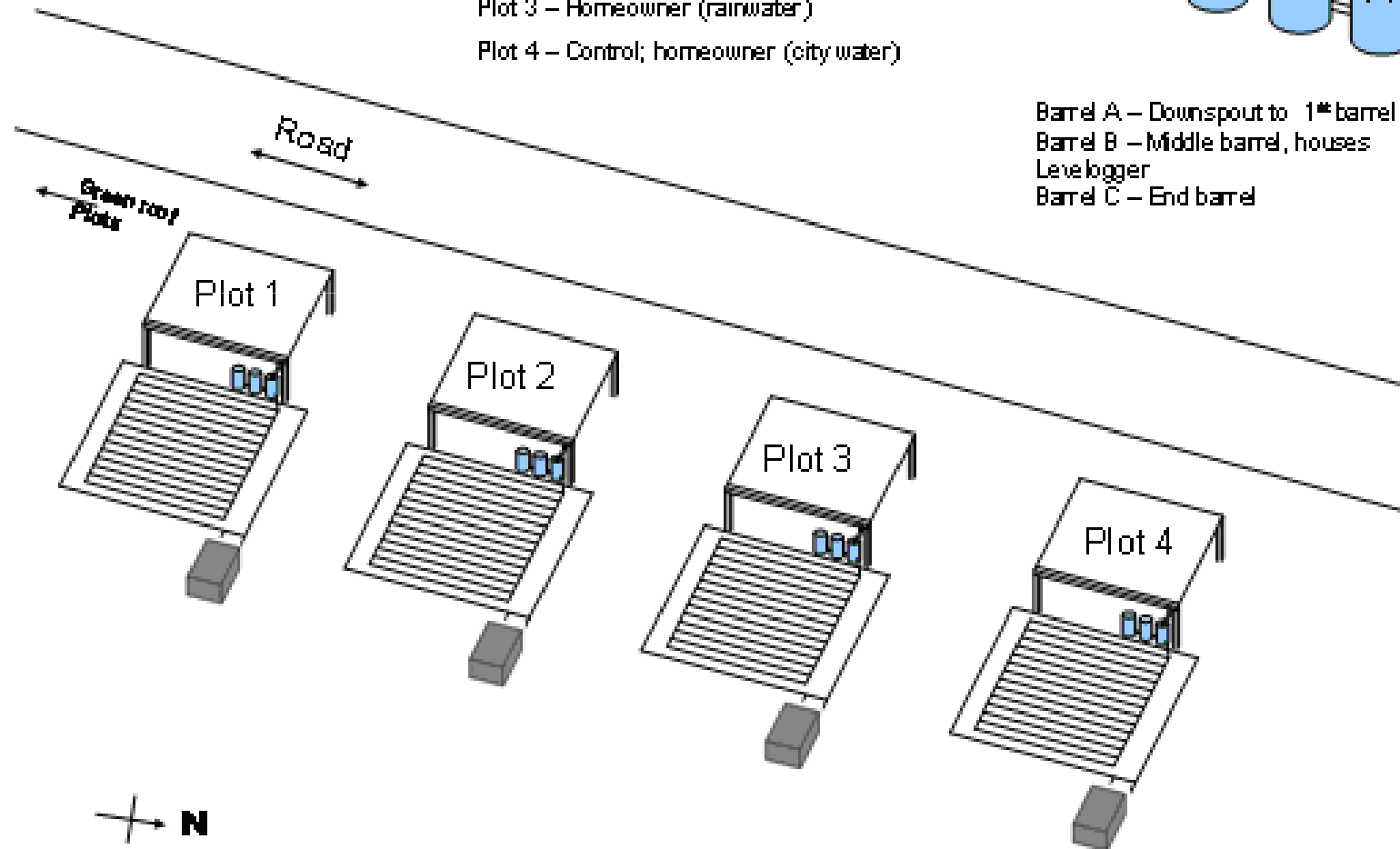
Plot 2 – Evapotranspiration

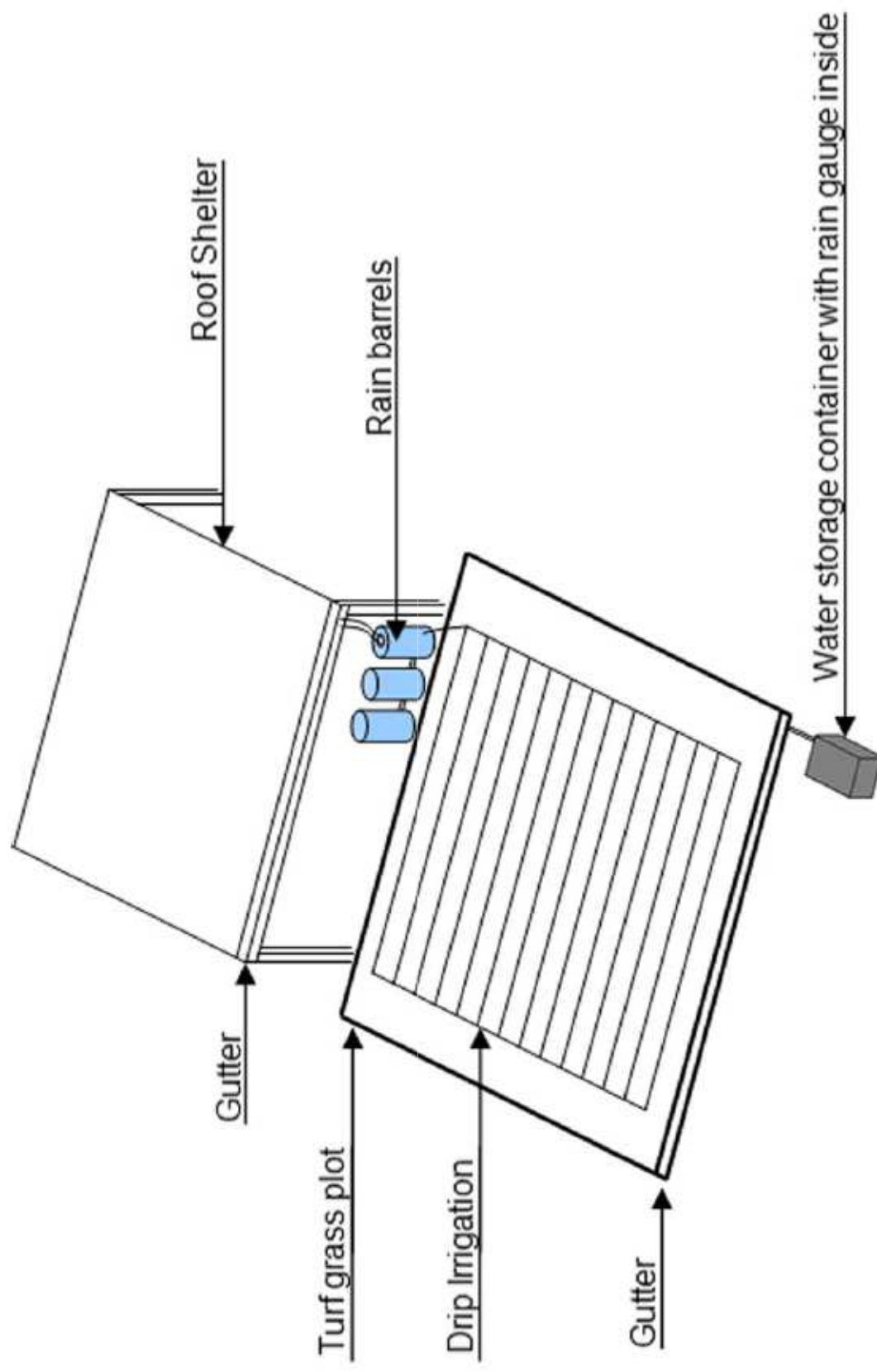
Plot 3 – Homeowner (rainwater)

Plot 4 – Control; homeowner (city water)

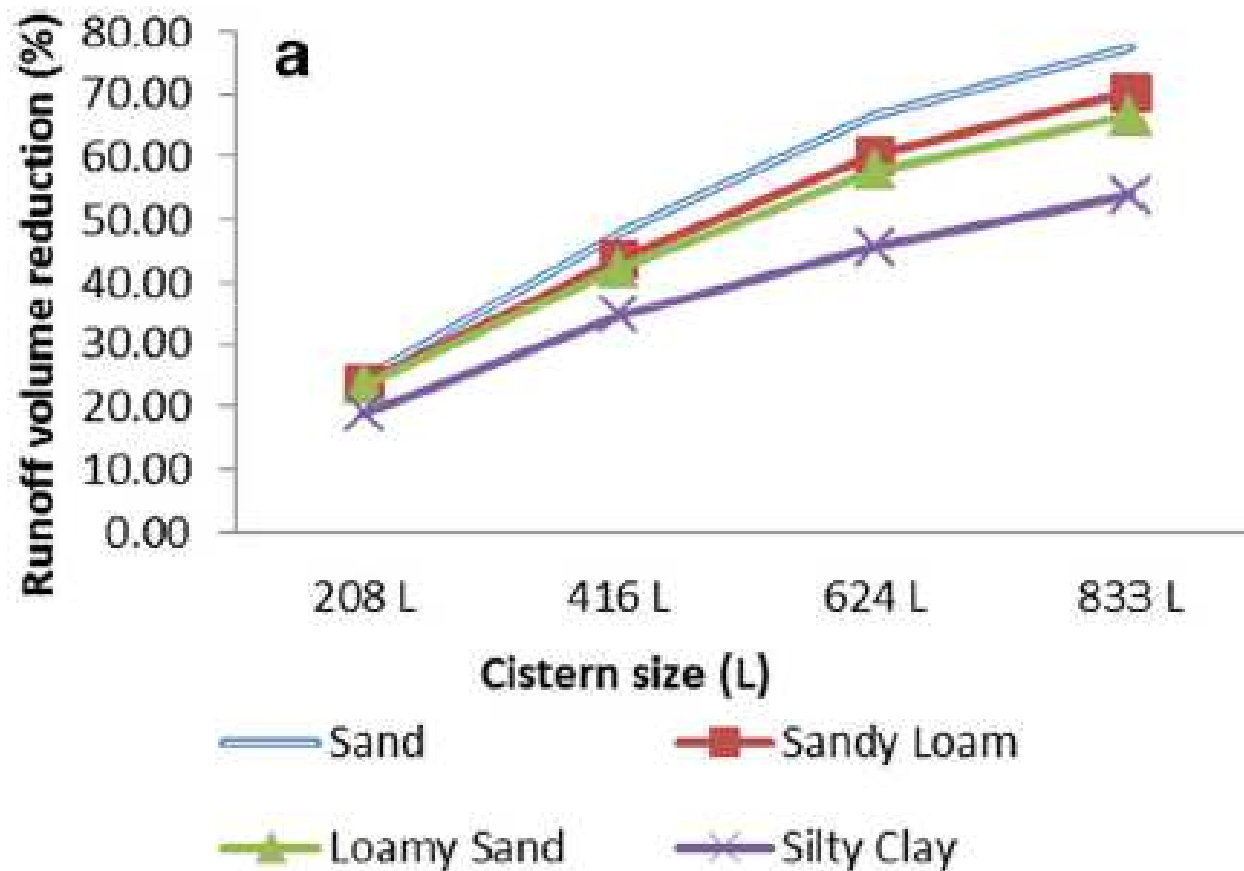


Barrel A – Downspout to 1st barrel
Barrel B – Middle barrel, houses
Level logger
Barrel C – End barrel

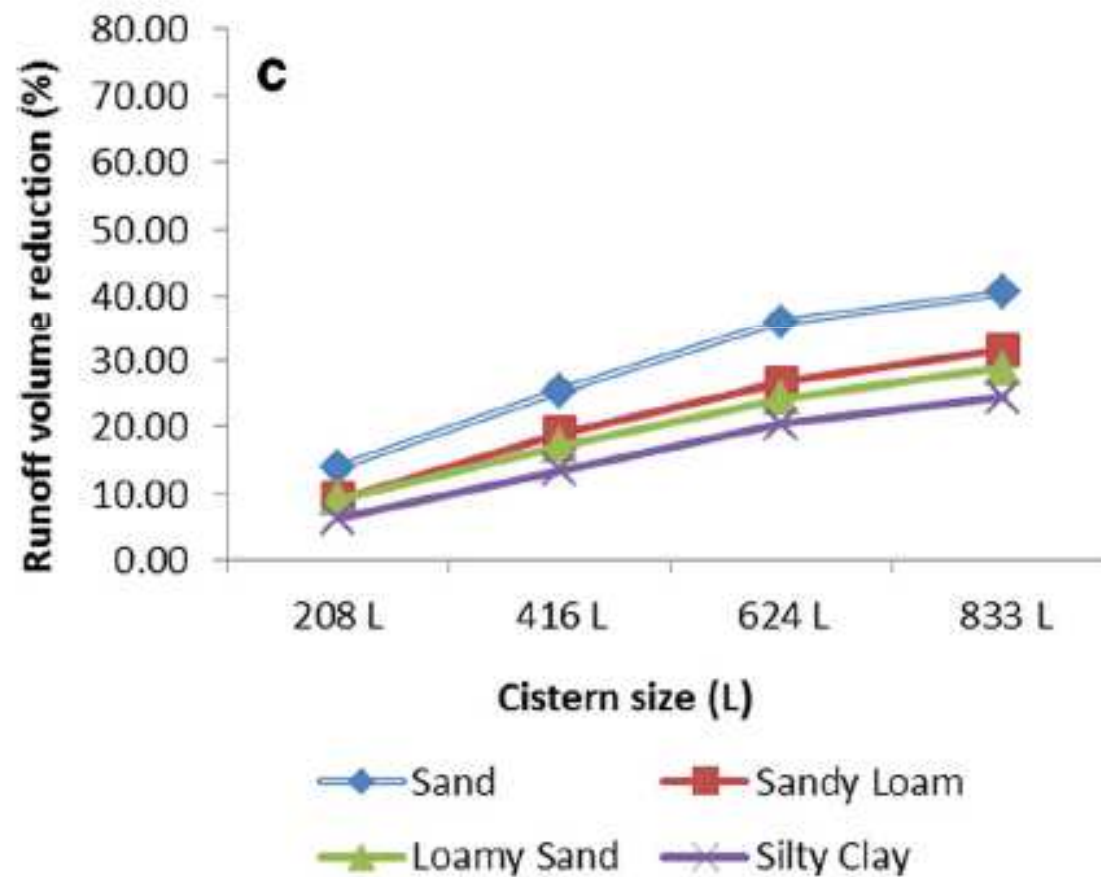




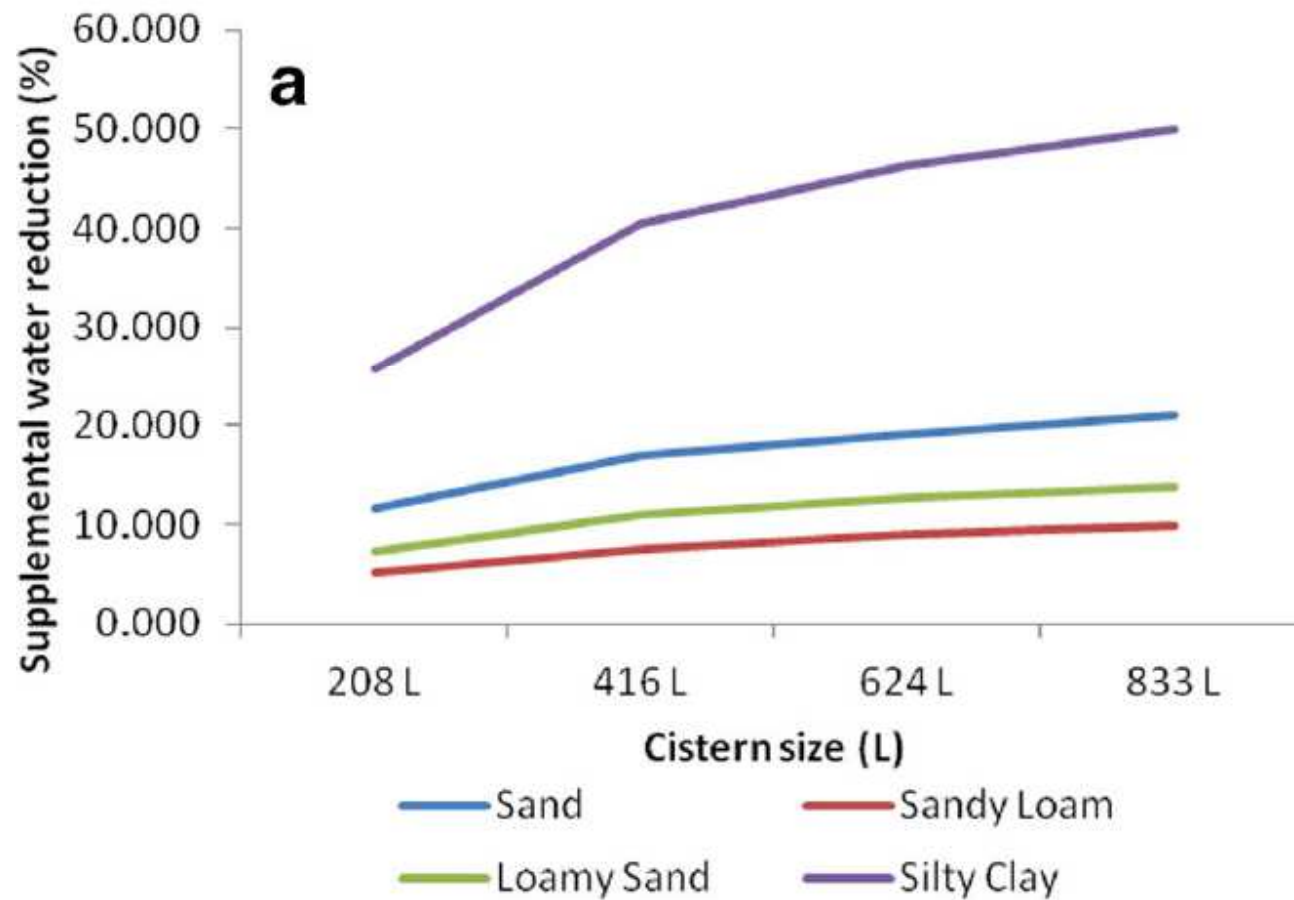
Runoff from time based



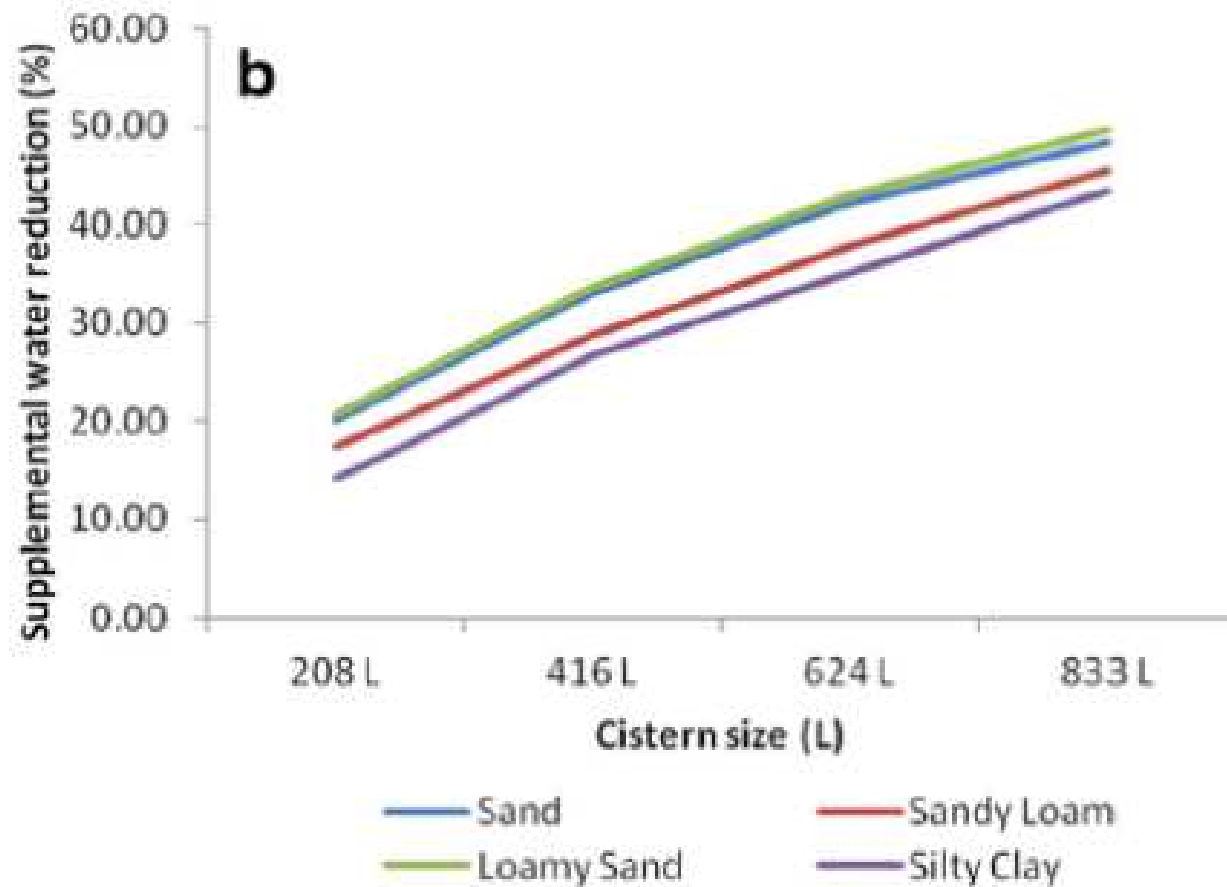
Runoff from ET-based



Water Savings from RWH



Water Savings Soil Moisture



Acknowledgements

- ▣ This research was made possible by a CWA 319 (h) NPS grant provided by USEPA and TCEQ
- ▣ Texas AgriLife Research for providing funds and the location for the constructed BMPs.
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